Folding/unfolding movements of hindwing and body morphological patterns in dung beetles

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In Scarabaeidae some complex foldings allow to recover the hindwings below the elytra when at rest. The sclerotized articular parts and thoracic muscles help the processes of folding and unfolding. This research highlighted that the folding mechanism is basically the same in the studied taxa, and it is articulated in at least five steps. The geometric morphometrics approach was applied to examine the overall shape variation in various body parts by both landmarks and semilandmarks methods. The shape and size correlations between hindwing and other body structures - as the pronotum, abdomen and elytron - were examined in representatives taxa of two scarabaeid subtribes (Drepanocerina and Onthophagina). Similarities and differences in morphological and evolutionary patterns were discussed. The results show how the morphological pattern variations are increasing and decreasing following strict and precise correlations between size and shape evolution of the body and the hindwing.